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# Biofuel and Indirect Land Use Change

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Whether anyone can plausibly account for the portion of greenhouse gas emissions that originate from land use changes around the world that are allegedly triggered by the global biofuel industry is a controversial topic. The Energy Independence and Security act of 2007 [1] mandates inclusion of any significant indirect land use change (ILUC) in the life cycle analysis (LCA) of a biofuel. The ILUC relates to the unintended consequence of releasing carbon emissions due to land-use changes around the world induced by the expansion of croplands for biofuel production. In addition to US Federal requirements, state of California biofuels policies also require inclusion of ILUC in LCA. In Europe, ILUC is not yet required, but there is a serious intent to include it as soon as modeling reaches a point where predictions are considered reliable. This Technote compares real world data with the biofuel ILUC assumptions and results and shows that there is still considerable need for additional research.

## ILUC Models

The US EPA and California Air Resource Board (CARB) uses several computer models in combination to estimate the ILUC impact. The EPA uses a model called GREET [2] to model US and foreign direct emission factors for fossil fuel and agricultural chemical production, FASOM [3] to simulate the impacts of policies on land use and GHG emissions, FAPRI [4] for international trade for grain, oilseed and livestock, DAYCENT [5] is used to estimate direct $N_2O$ emissions from agricultural activities, and GTAP [6] is used for global trade analysis.

None of the models being used were originally intended for the purpose of modeling ILUC from biofuels. However, numerous improvements and revisions are being made to these models to make them more suitable for this purpose. These improvements are supposed to provide greater spatial resolution, better representation of crop and livestock intensification, inclusion of co-products and their displacement effects, better handling of fertilizer usage and impacts, and incorporation of additional fuels and feedstock. Given these improvements, it is reasonable to expect that overall modeling will become more reliable, although some experts argue this is a pipe dream and never will be realized [7].

## Model Limitations and Evaluations

Deforestation is occurring constantly, due to many causal factors some of which are independent while others are interdependent. These factors, which are mostly local but sometimes regional or national, fall into six broad areas: 1) economic (legal and illegal mining and other activities unrelated to commodity prices), 2) biophysical (fire, pests), 3) cultural (communal decision making), 4) technical (slash and burn to boost fertility), 5) demographic (rapid growth of populations and the rural poor), and 6) political (programs to help the landless poor). The current ILUC models neither account for other than economic factors nor is there any easy way for them to do so. Even for the economics part, the models do not account for price-yield elasticity, land productivity increase from improved technology, or double cropping.

Since the beginning of the global biofuel industry around the year 2000, we are now getting some data to evaluate against the model hypothesis and predictions. If the forests are being converted to agricultural land to balance the food supply, as the model have assumed, we should see the total agricultural land[1] of the world increasing. The data from the World Bank [8] shows that the reverse is true. The world's total agricultural area is shrinking at the rate of 9.4 million acres per year since 2000. US biofuel production, on the other hand, has seen most of its growth since after 2000 (Fig. 1). This shows that the model prediction that forest land is being converted to increase agricultural land is invalid.

The reason that the world needs less area to grow food is because of improved land productivity. Worldwide, land productivity has been increasing at an average of 2.8% per year since 2000. For cereal, a major food crop around the world, the yield is increasing at the rate of 50

[1] Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures

lbs/acre per year. World population growth rate, on the other hand, has been declining currently at 1.14% [8].

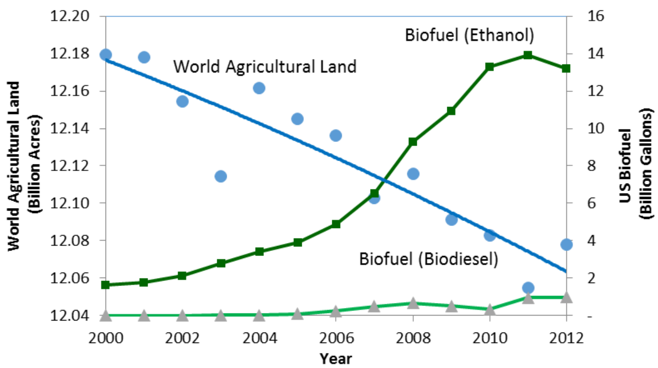


*Figure 1. World agricultural land is decreasing at 940 million acres/year despite increase in US and worldwide biofuel growth. Source:[8, 10, 11]*

ILUC analysis assumes that the use of an agricultural commodity to make biofuel takes it away from traditional use forcing a price increase for that commodity. This price increase is assumed to be the main driver for indirect land use change. However, analysis of the world food price index data [9] does not support the claim. Comparing the price indices for cereal and oil price to the overall food price index before the biofuel era of 2000 and after, there is no significant change in the price pattern. Data from 1990 to 2000 show that for each one percent increase in overall food price, the cereal price increased by 1.12% and the oil price increased by 1.18%. For the period of 2001 to 2015, the corresponding price hikes were 1.13% for cereal and 1.12% for oil price for each percent increase in the overall food price. The price increase rate difference was statistically insignificant. There has been no change in food price inflation rate before and after biofuel era hence voiding the ILUC model assumptions. This observation can be explained from the fact that the co-products of ethanol and biodiesel provide a significant amount of feed supply. Although corn is the primary feedstock for the US ethanol industry, 31% of the corn used to make ethanol ends up as Distiller's Dried Grains with Solubles (DDGS) and an additional 0.9% of the corn becomes corn oil. In the case of soybeans, the primary product is meal, not the oil. Soybeans contain about 80% meal and 20% oil. Further, of the total biodiesel production in the US, only about 55% of the feedstock comes from soybean oil.

## Conclusion

Inclusion of indirect land use change in LCA is easier said than done. The core weaknesses relate to insufficient data and model assumptions that are not representative of the real world. The use of layered models with single point data from a year with varying levels of uncertainty compounds the uncertainty and makes the level of uncertainty difficult to assess. Real world data neither support the model assumptions nor the predictions. In contrast to the predictions, world agricultural land is shrinking and grain and oil price inflation were the same before and after the biofuel era. Given the wide margin of error, basing regulatory decisions on such weak model predictions are not justified.

Considering the weakness of the models and the complexity of the problems, it is better to postpone the use of ILUC in public policy at least until we settle the debate and verify ILUC predictions. The premature inclusion of ILUC in law-making creates uncertainty for biofuel development, increases the cost of doing business and shifts resources away from real solutions.

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